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NOISE SUPPRESSING FILTER FOR MICROPHONE

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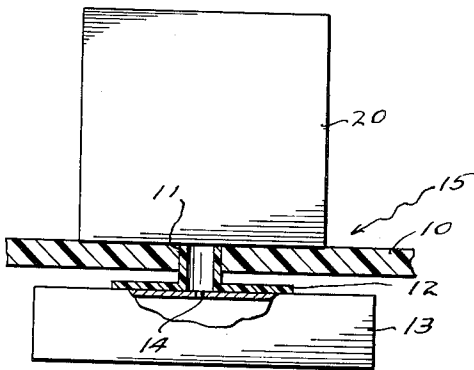


Fig. 1

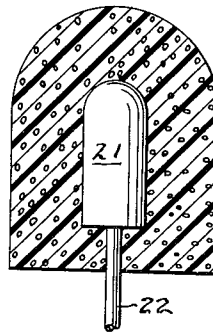


Fig. 2

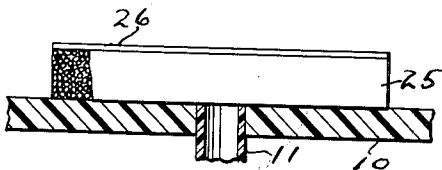


Fig. 3

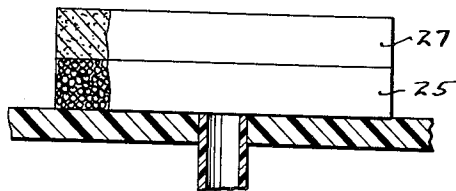


Fig. 4

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## 3,154,171 NOISE SUPPRESSING FILTER FOR MICROPHONE

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1 Claim. (Cl. 181-31)

This invention relates to a method and apparatus for the elimination of sounds created by local air turbulences at a microphone.

Heretofore it has been recognized that undesirable sounds were picked up by a microphone due to the passage of moving air over the microphone. The air moving relative to the microphone could be due to wind or due to the fact that the microphone itself was moving through the air, as in the instance of a moving car or airplane. The turbulences caused by this relative movement of the air and microphone were so great as to materially interfere with and/or mask out desired sounds and thus make the transmission of speech and other desired sounds unintelligible. This effect is particularly apparent in microphones used in outdoor public address systems and in hearing aids of the type usually worn on the head, such as eyeglass hearing aids and over-the-ear hearing aids.

Previously the only known means for eliminating this undesired sound was to enclose the microphone and the operator with some kind of a wind screen or total enclosure or to wrap the microphone with a piece of cloth. Either of the expedients are undesirable and were not as completely effective as could be desired.

By the present invention we are able to provide a means for eliminating substantially in their entirety and to a considerably greater extent than the previous means used, extraneous noises generated due to these locally generated sounds because of wind velocity.

Briefly, the invention contemplates causing a diffusion of the undesired localized turbulences without recombination prior to impingement on the sound responsive element on the microphone and diffusion and recombination of the desired sounds which then impinge upon the microphone.

The invention will be described in conjunction with an explanation of a theory of its operation. It should be understood, however, that if later developments should indicate that the theory expounded may be scientifically incorrect, that it in nowise effects the invention.

In order to better understand the invention, reference should be had to the accompanying description illustrated by the accompanying drawings and which forms a part of this specification.

In the drawings:

FIG. 1 is a diagrammatic view illustrating the basic concept of the invention;

FIG. 2 is another diagrammatic view illustrating an application of the invention to a conventional microphone of the public address type;

FIG. 3 is a diagrammatic view illustrating a form of the invention as applied to a hearing aid; and

FIG. 4 is a diagrammatic view of another modification thereof.

In the drawings, like parts have been designated by like reference characters.

As previously stated, the undesired sounds are created by local turbulences which in turn are created by relative movement of the air and microphone which causes localized turbulences that enter into the sound opening of the microphone and create a roaring sound which masks the desired sounds. These sounds, it has been discovered, in substantially all instances, approach the microphone

from a direction laterally of the microphone and usually are in the same direction at any one instant. Although the direction may change, such change is relatively slow due to wind shifts or a change in the direction of movement of the microphone or the manner in which the microphone may be presented to the relative wind. Desired sounds are usually of a considerably lower frequency than the undesired sounds and actually approach the microphone so that they impinge upon the microphone from all sides that are presented to the sound at substantially the same time and with the same velocity.

The method consists of diffusing, without recombination, the undesired sounds, and, at the same time, diffusing but recombining the desired sounds before impingement upon the sensitive elements of the microphone.

FIG. 1 is illustrative of an embodiment of the invention. In the figure the fragmentary casing, which may be that of a hearing aid of the over-the-ear type, is shown at 10. It is provided with an aperture through which a highly resilient coupler which comprises a hollow cylindrical stem 11 extends. The inner end of the coupler is provided with a laterally extending circumferential flange 12 which seats against the outer wall of a casing 13 housing the microphone. This outer wall is provided with an opening 14 which is disposed coaxially with the bore of the tube 11. The above is conventional construction and sounds normally enter through the tube 11 and the opening 14 into the microphone, as is well known to those versed in the art.

As previously stated, undesired sounds passing over the exterior surface 10 cause turbulences which are in the nature of random pulses of sound of various amplitudes. These are created because of the wind approaching and striking the surface in the direction of the wavy arrow 15. It should be noted that this is a directional movement of air which may come from substantially a lateral direction, although not necessarily since it could come from a direction normal to the surface. Those coming from the lateral direction cause the turbulences at the surface which are carried over the opening to the tube 11. Those that come from a direction normal to the surface impinge upon the edge of the opening into the tube 11 and create disturbances at this point. It should be borne in mind that wind is an entirely different phenomenon from a sonic compression wave. Wind at any one instance can be considered as a moving body of fluid, whereas a sonic compression wave is not a moving fluid, in the sense that wind is, because it consists of alternate compressions and rarification of air as distinguished from the steady fluid flow. The wind therefore generates these turbulences, which after being generated although being similar to a sound wave, are of a highly localized and extremely short duration which are blown or carried by the wind across the opening. Obviously the greater disturbances are caused by the winds which attack the surface at an angle. However, it is to be noted that a disturbance created to the right side of the opening in the wall 10 does not arrive at the opening at the same time as a disturbance created by the wind striking the wall on the other side of the opening. We have found that this noise can be eliminated, in substantially its entirety, by placing over the opening a material which causes a diffusion of the various turbulences, causing substantial cancellation. Such a material may be in the form of a block of material indicated at 20, which can be round, square or any form so long as it covers the opening and an area surrounding the opening. It should be a material which acts as a mass of heterogeneously disposed baffles acting as a muffler which accepts and diffuses the turbulences in such a manner that a cancellation, due to recombination, takes place within the block of material. Such a material may be cellular in nature, such as one

3

of the iso-cyanates, of which one typical example is on the market under the name of "urethane." The turbulences are cancelled because they are of a random nature and are diffused in the material. This can be understood when it be considered that the cause is usually coming from one side or the other of the material.

On the other hand, sound waves which are substantially flat in nature attack the material from all sides substantially simultaneously and, although they are diffused as they pass into this material, they are recombined at the opening to the casing 10 to provide a sound wave substantially the same as the original wave, within the range of desired audibility.

FIG. 2 shows a conventional microphone 21 of the well known type, supported by a support 22 and it is enclosed on all sides by a mass of urethane or its mechanical equivalent. The entire surface of the microphone being covered with this material, the effect that takes place is the same as with the hearing aid described.

It will be appreciated that in many instances, although the sound is efficiently transmitted and the turbulences dissipated, that the device of FIG. 1 has the disadvantage that it is bulky, presents an undesired appearance and because of its size is easy of dislodgement. It is therefore desirable that the size of the apparatus be reduced to as small a compass as is possible without detracting from its efficiency as a noise filter or muffler.

We have discovered that a device shown diagrammatically in FIG. 3, will operate in a very efficacious manner. In this instance, a thin slab 25 of urethane is provided, having sufficient area to cover the opening to the tube 11 and a zone surrounding the surface. It may take any particular form desired, such as circular, square, rectangular or polygonal. The outer surface of the porous material is provided with a thin layer of material relatively impervious to sound waves, such as metal, plastic or fiber 26.

In this case, the undesired created sounds will usually be coming in from one side or the other. At no time will they arrive at opposite edges at the same time, in exact synchronism with each other. Therefore, their passage into the material is accompanied by a diffusion in the material and an ultimate recombination in a heterogeneous manner, eliminating noise. On the other hand, desired sounds which are approaching the device from a plane which may be considered substantially normal to the surface 10, arrive at all edges of the porous material at substantially the same time, enter into the material and are diffused but recombined to provide intelligible sound which passes into the opening 11.

A particular efficacious device is shown in FIG. 4. In this instance, a thin layer of urethane 25 is provided surrounding the sound opening and has secured thereto a layer of felted material of a porous nature 27, which may be hair felt, cotton felt or any fibrous material. In this instance, the felted material is of a considerably greater density than the urethane. As a typical example for a

4

standard hearing aid, the layer of urethane would be approximately  $\frac{1}{16}$  of an inch thick and the felt could be the same thickness or possibly slightly thinner. The operation of the device is similar to previous embodiments in that undesired sounds created by turbulences are eliminated because they pass into the urethane in a random manner and they are combined in such a manner as to average out the sounds and cause a muffling effect, previously indicated. An additional effect, however, is realized in that the felt is pervious to both desired sounds and undesired turbulences which may penetrate the combination from all sides. All sounds may pass through the felt. The sounds due to noise however, due to a heterogeneous character, are largely cancelled within the felt itself, whereas the desired sounds, although broken up on their passage through the felt, are not of a heterogeneous nature and therefore recombine, with the greatest recombination occurring in the more open and porous urethane area. Sounds and turbulences arriving at the edges of this material are effected in the same manner as previously described for the other embodiments.

It will thus be seen that we have provided a method for combining undesired heterogeneous disturbances due to turbulences of air and created in a localized area in such a manner that the individual characteristics of the discrete disturbances is substantially completely dissipated and at the same time desired sonic sounds, although distributed in their passage through the material, are recombined due to their non-heterogeneous nature into usable audible sounds having substantially the same complete characteristics as the original sound within the desired frequency range.

Having thus described our invention, we are aware that numerous and extensive departures may be made therefrom without departing from the spirit or scope of the invention as defined in the appended claim.

We claim:

An apparatus for the elimination of undesirable sounds created by air flowing against or over a surface having a wall formed to define an opening and duct means connected to said opening and communicating with a microphone and the acceptance of desirable sonic compression waves which comprises a first layer of highly porous material disposed over the opening and the surface immediately surrounding and beyond said opening and a second layer is disposed over the first layer outwardly from the opening in the surface and is comprised of a material of less porosity than the first material.

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